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Patentanmeldung Nr. **Patent application No.** **Demande de brevet n°**

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Der Präsident des Europäischen Patentamts;
Im Auftrag

For the President of the European Patent Office

Le Président de l'Office européen des brevets
p.o.

I.L.C. HATTEN-HECKMAN

DEN HAAG, DEN
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Blatt 2 der Bescheinigung
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Page 2 de l'attestation

Anmeldung Nr.:
Application no.: 00201498.3
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Anmeldetag:
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Anmelder:
Applicant(s):
Demandeur(s):
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Bezeichnung der Erfindung:
Title of the invention:
Titre de l'invention:
Method for manufacturing a cathode ray tube

In Anspruch genommene Prioriät(en) / Priority(ies) claimed / Priorité(s) revendiquée(s)

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Remarques:

Method for manufacturing a cathode ray tube.

The invention relates to a method for manufacturing a display tube comprising the step of press-forming a glass display panel.

In the known methods a glass panel is press-formed which usually takes place at very high temperatures (1000°C-1100°C). In this manner a glass face panel can be formed. Cathode ray tubes, for example, comprise a glass display panel which is press-formed.

Cathode ray tubes (CRT's) are becoming of ever more greater size, thus increasing the weight of the CRT's. Furthermore the front surface of the glass panel is becoming ever more flatter. However, increasing the flatness of the front surface of the face panel generally increases also the weight of the glass panel because the thickness of the glass panel has to be increased to ensure safety against implosion or explosion of the CRT.

There exists therefor a great need for increase in strength of the CRT and in particular of the glass panel. An increase in the strength of the glass panel may improve the yield.

The present invention is aimed at providing a method which enables increasing the yield of the method and/or reducing the weight of the glass panel.

To this end the method in accordance with the invention is characterized in that during at least a part of the press-forming step of the glass panel the inside corners of the panel are kept at a surface temperature below the surface temperature of the centre of the glass panel.

The invention is based on the insight that during and after glass panel pressing, inhomogeneities in the stress level in the panel can occur. In particular the stress at the inner corners of CRT panels (i.e. the areas where the face and side walls of the panels join) may become less compressive than on the remaining parts of the surface of the panel. This reduces

strongly the efficiency of the panel processing during CRT manufacturing thereby reducing the yield and can seriously affect the safety of the tubes. This is in particular important for panels with an (almost) flat inner and/or outer surface such as Real Flat panels, because the amount of stress required for processing and safety in these panels is higher than for less flat panels. Since stress inhomogeneities are often the result of temperature difference, at first sight it seems counterproductive to introduce temperature inhomogeneities during press forming. The invention is, however, based on the insight that one important reason for the occurrence of high inhomogeneities in the stress is the fact that the hot glass is press formed in a relatively cooler press. The outer surface temperature is thus lower than the temperature of the inner parts of the glass (which have been less cooled). After pressing, the inner parts of the glass are still at a higher temperature that the surface temperature. After pressing, the surface temperature of the glass increases again due to heat transfer from the (still hot) bulk of the glass panel to the surface parts. This reheating process does not have an equal effect in all parts of the panel. In the corners the mass of the glass is relatively large whereas the contact surface with the press is relatively small. At the corners a relatively large reheating effect occurs. In the centre the mass of the glass is relatively small due to the relatively small thickness of the glass panel, whereas the surface is relatively large. Thus a relatively small reheating effect occurs. Furthermore the time during pressing between the 'cold' plunger and the glass is relatively shorter in the corners than at the centre. Thus the surface temperature itself may be higher at the corners than at the centre. The reheating effect induces large temperature difference in the glass panel and in particular large temperature differences near the corners. As a result larger stress release (reducing the stress) occur at the corners, which are the parts of the panel in which the tensile stresses due to geometrical reasons tend to concentrate. In the method in accordance with the invention the corner parts of the panel are during press forming at a lower temperature than the centre. The reheating effect will occur. This effect will increase the temperature more in the corners than in the centre but since the starting temperature (i.e. the temperature during press forming) is less in the corners than in the centre, the temperature differences will decrease, leading to a decrease in stress release due to reheating, in particular near and around the corners, increasing surface compression and thereby the safety of the panel. This effect may for instance in practice be used to manufacture panels with a lower weight, or panel with a flatter front surface, or to reduce the fall-out (=percentage of panels that do not pass safety tests) or any combination of these beneficial effects.

Preferably around the inside periphery of the glass panel the surface temperature is kept below the surface temperature of the centre of the glass panel. The above described reheating effect has it's greatest effect in the corners. It occurs however also at other positions around the periphery of the glass panel. For some glass panels the thickness of the panel is even thicker at the ends of the short or long axis of the glass panel (N-S-E or W ends). In such circumstances a relatively large reheating effect could occur at these points and keeping the surface temperature below the surface temperature at the centre will be beneficial.

Preferably the corners or the periphery are during at least a part of the press forming kept at a surface temperature which lies 50-150°C below the temperature of the centre of the display panel. The above described reheating effect induces surface temperature differences of the same or similar magnitude, depending on the panel design (flatness, thickness) and the speed of pressing (generally 1-3 panels per minute).

In preferred embodiments the surface temperatures after press forming does not raise above the strain point of the glass, preferably they stay at least 30 degrees Kelvin below the strain point. When, due to the reheating effect the surface temperature raises above the strain point the strain is most effectively released and large stress inhomogeneities occur.

These and other aspects of the invention will be apparent from and elucidated with reference to the embodiments described hereinafter.

In the drawings:

Fig. 1 is a schematic, partly cut-away view of a display device comprising a cathode ray tube,

Fig. 2 illustrates the method in accordance with the invention,

Fig. 3 illustrates in a graphical form the temperature of the glass panel during and after pressing of the method in accordance with the invention at various positions of the glass panel,

Figs. 4A and 4B illustrate in graphical form the stresses inside the glass panel.

The Figures are purely schematic and not drawn to scale. In particular for clarity, some dimensions are exaggerated strongly. In the Figures, like reference numerals refer to like parts, whenever possible.

Fig. 1 is a very schematic, cut-away view of a display device comprising a cathode ray tube 1 having a glass envelope 2 which includes a display panel 3, a cone 4 and a neck 5. In the neck 5, there is an electron gun 6 for generating one or more electron beams 9. The electron beam is focused on a phosphor layer 7 on the inner surface of the display panel 3 and deflected across the display panel 3 in two mutually perpendicular directions by means of a deflection coil system 8.

Display devices often comprise cathode ray tubes or television display tubes 1 which are entirely made of glass and which are built up of two or more portions with glass walls of different thicknesses or different heat-absorption characteristics. For example, a glass television display tube 1 customarily comprises a glass display panel 3 and a glass cone 4 which are separately produced and subsequently united by fusing or by using a (solder) glass frit, the joint formed being hermetically tight. The display panel 3 of such tubes is formed by a glass wall whose thickness is much greater than the wall thickness of the cone parts of such tubes. Such a greater wall thickness of the display panel 3 serves to ensure that it is sufficiently rigid when the eventual tubes comprising such a screen are evacuated.

Figures 2A and 2B illustrate the method in accordance with the invention. In a first method step (Fig. 2A) a glass volume 21 at a high temperature (typically 1100°C-1000°C) is supplied to a press 22 having moulds whose forms roughly correspond to the form of the glass panel to be made. A glass panel is press-formed in the usual manner by pressing the plunger 23b in the die 23a, with the glass volume 21 in between (Fig. 2A). The warm glass being in contact with the relatively cold press will cause the temperature and in particular the surface temperature of the glass to drop. The corners of the plunger are cooled by means of a flow of cold gas or liquid 24. Nozzles 25 are provided to guide the flow to the corners. The plunger may be provided with a tissue (such as a stainless steel tissue 26), preferably at least at the corners 26, to improve the heat transfer of the material of the plunger to the glass. After formation the glass panel is taken from the press and further cools down.

Figure 3 illustrates a few points of the glass panel for which in figure 4A and 4B the temperature is illustrated in a graphical form. The point CR is a point at the bulk of the corner inside the glass. The point CRS is the transition point at the corner at the inner surface of the panel. The “inside corner of the panel” denotes this point and an area surrounding this point. The point CE is a point at the bulk of the central part of the glass panel inside the glass, the point CES is a point at the centre at the inner surface of the glass.

Figure 4A illustrates schematically the temperatures at these points in a conventional method. The vertical axis denotes the temperature in degree Celsius, the

horizontal axis time in arbitrary units, the units chosen such that the temperature drop per unit is more or less the same. Point 1 stands for the temperatures immediately after pressing. As can be seen the temperatures at the centre drop faster than at the corner. Also visible is a reheating effect at the points CRS and CES, i.e. the temperature increases initially. This reheating effect is much larger at point CRS than at point CES. As a consequence a temperature difference in surface temperature (CRS-CES) occurs which runs up to approximately 90°C-100°C. As a consequence the compressive surface stresses are much more released at the corners than at the centre. This is amongst others dependent on the maximum surface temperature during reheating in comparison to the strain point of the glass. In this example the temperature at the corner rises above the strain point in this example the strain point Ts is approximately 595 degrees Celsius. In particular when this happens the strength of the panel is reduced.

Figure 4B illustrates schematically the temperatures at these points in a method in accordance with the invention. Again, the vertical axis denotes the temperature in degree Celsius, the horizontal axis time in arbitrary units, the units chosen such that the temperature drop per unit is more or less the same. Point 1 stands for the temperatures immediately after pressing. At that point in fact the temperature differences are increased since the difference between the surface temperature at the corner and the centre is greatly increased. As can be seen the temperatures at the centre drop faster than at the corner. Also visible is a reheating effect at the points CRS and CES, i.e. the temperature increases initially. This reheating effect is much larger at point CRS than at point CES as in figure 4A. However, in the method in accordance with the invention the corners have been at a temperature lower than the temperature at the centre. In this example the difference Δ was 120°C. As a consequence the difference in temperature CRS-CES is, except for the first few point (1-2) kept to a much lower value (approximately 20°C-25°C) resulting in a more homogeneous stress distribution (i.e. a smaller difference in stress between corners and centre) which improves the quality of the panel. Both temperatures CES and CRS stay during the reheating process below the strain point Ts as is preferred. In embodiments the corners of the glass panels may be cooled after press forming, i.e. during the reheating process to keep the temperature below the strain point. Preferably both temperatures stay at least 30 degrees below the strain point. In this respect it is important to note that stress release in the glass panels depends in general on the annealing temperature range, which depending on the glass type lie around 550°C-600°C. The stress release determines the surface stresses in the finished product to a large degree. In figures 4A and 4B emphasis is laid on the surface

temperature in the corners versus the surface temperature in the centre. The illustrated reheating effect may not be limited to the corners but in embodiments could occur around the periphery. In embodiments of the invention the periphery is kept at a lower surface temperature.

Within the concept of the invention in it's broadest sense the mention of "a surface temperature" is not to be unduly and unjustifiably restrictively interpreted as "thus there must be one and only one fixed value for every point in the corner or periphery". There could and most likely will be during the press forming a temperature gradient going from a corner to the centre or going around the periphery. There where within the concept of the invention a temperature difference between centre and corner or periphery is mentioned the temperature difference is between the centre and the transition point of the corner or of the periphery, i.e. the transition point or area where the radius of curvature of the panel is the smallest. The "inside periphery" is the transition line at the inside of the glass panel and an area surrounding this transition point. Preferably also after press forming the inside corners or inside periphery is cooled more than the centre. This may for instance be done by blowing relatively cold gas in the inside corners of the panel. Such embodiments do not exclude that the centre is not cooled at all.

It will be clear to a person skilled in the art that within the framework of the invention many variations are possible. In short the invention can be described by the following:

To increase the strength of the glass panel, for example of a CRT, the surface temperature of the glass panel at the inner surface of the corners is during press forming reduced to temperature below the surface temperature at the inner surface at the centre, the difference being preferably 50°C-150°C. The forced cooling at the corners compensates for the larger reheating effect in the corners than at the centre that occurs after formation. As a consequence of this compensating effect a more homogeneous distribution of surface stresses is obtained, increasing the strength of the glass panel. Preferably the surface temperature is below the strain point during press forming.

21.04.2000

CLAIMS:

1. Method for manufacturing a display tube comprising the step of press-forming a glass display panel in a press having a plunger, characterized in that during at least part of the press-forming step of the glass panel the surface temperature of the inside corners of the panel is kept at a surface temperature below the surface temperature of the centre of the glass panel.

2. Method as claimed in claim 1, characterized in the difference in surface temperature between corner and centre is between 50°C and 150°C.

3. Method as claimed in claim 1, characterized in that during at least a part of the press-forming of the glass panel the inside periphery of the panel is kept at a surface temperature below the surface temperature of the centre of the glass panel.

4. Method as claimed in claim 1 or 3, characterized in that after press forming the inside corners or inside periphery is cooled more than the centre.

5. Method as claimed in claim 1 or 3, characterized in that the surface temperature of the inside corners and/or inside periphery are during and after press-forming below the strain point of the glass.

6. Method as claimed in claim 5, characterized in that the surface temperature of the inside corners and/or inside periphery are during and after press-forming at least 30 degrees Celsius below the strain point of the glass.

7. Method as claimed in claim 1, characterized in that the plunger is at the corners provided with heat transfer elements to improve the heat transfer of the material of the plunger to the glass.

8. Method as claimed in claim 6, characterized in that the plunger is provided with a stainless steel tissue as a heat transfer element.

ABSTRACT:

To increase the strength of the glass panel, for example of a CRT, the surface temperature of the glass panel at the inner surface of the corners is during forming reduced to temperature below the surface temperature at the inner surface at the centre, the difference being preferably 50°C-150°C. The forced cooling at the corners compensates for the larger reheating effect in the corners than at the centre that occurs after formation. As a consequence of this compensating effect a more homogeneous distribution of surface stresses is obtained, increasing the strength of the glass panel.

Fig. 2b

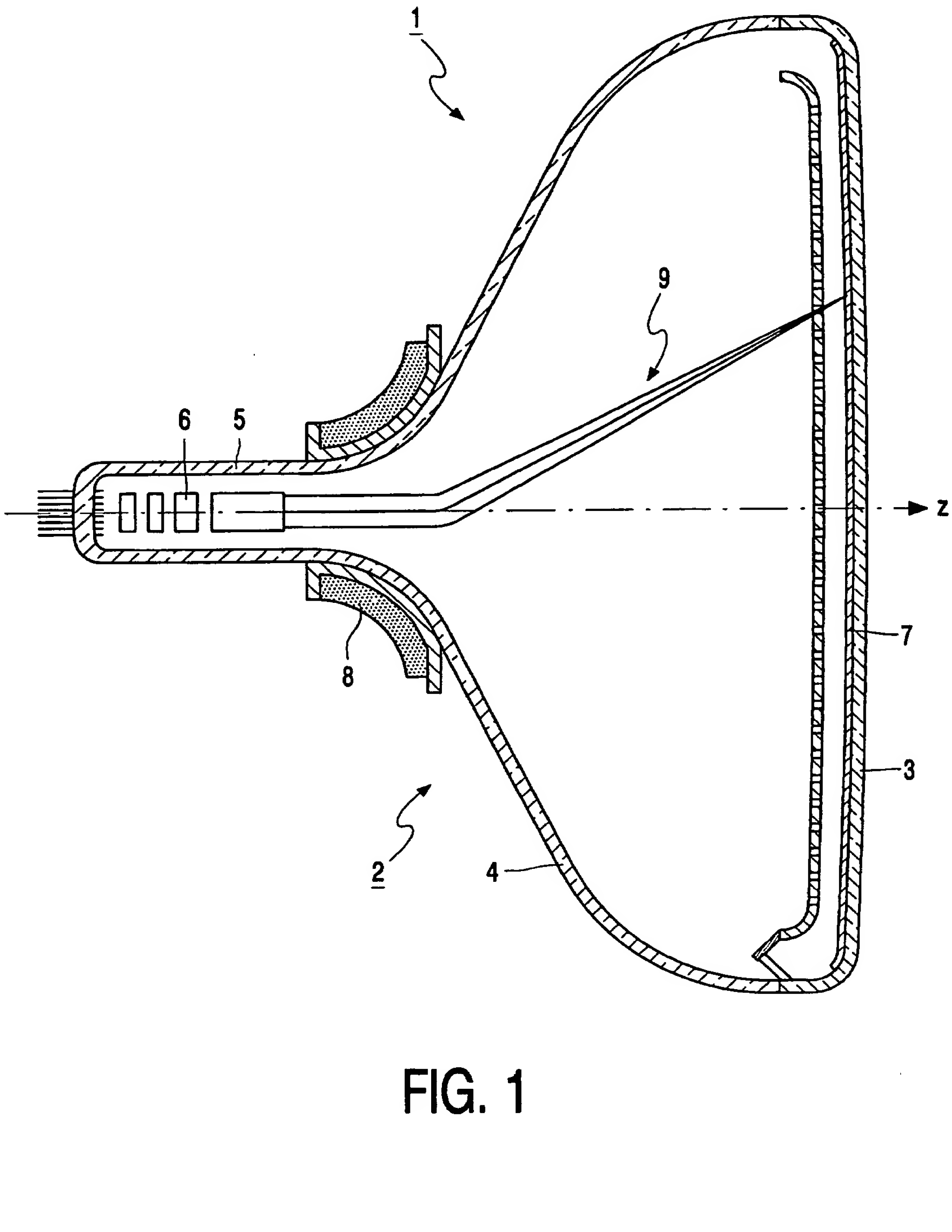

FIG. 1

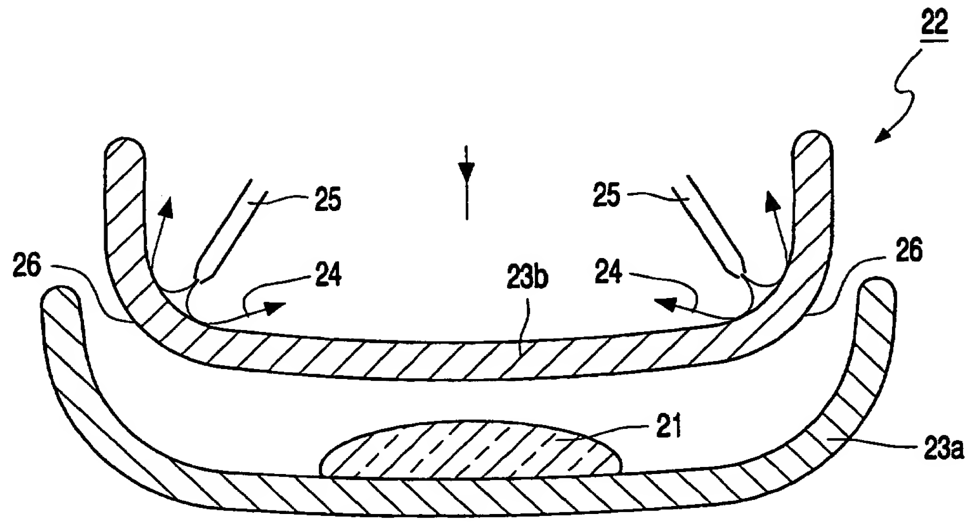

FIG. 2A

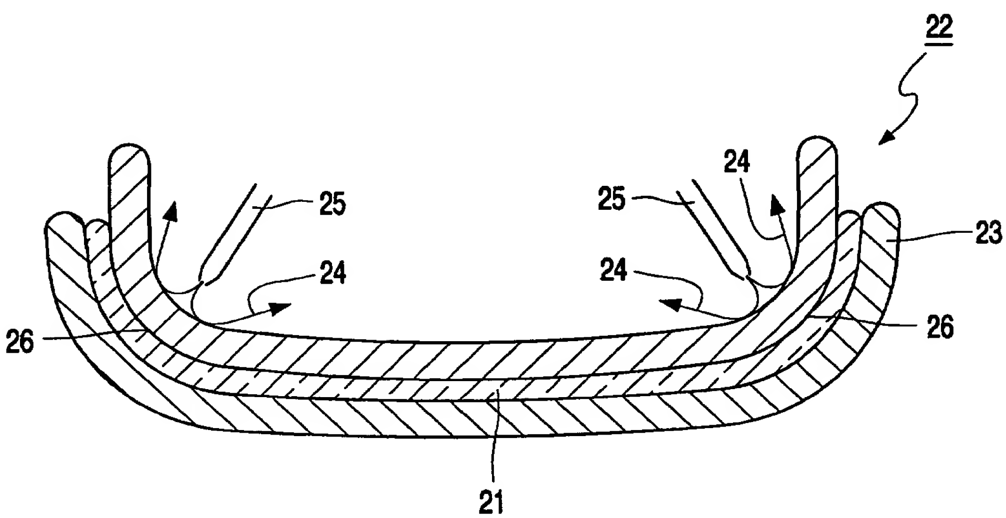

FIG. 2B

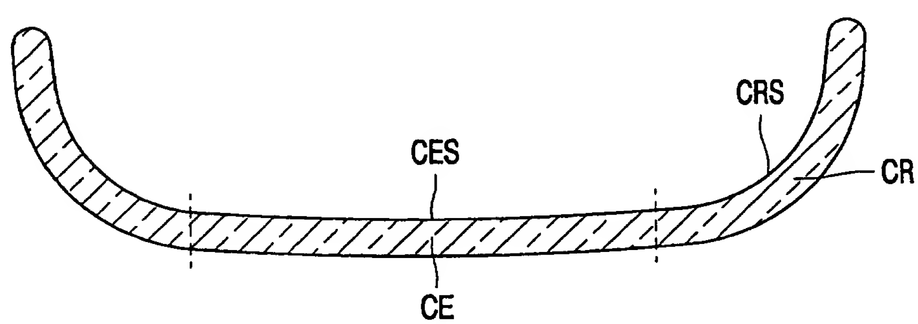

FIG. 3

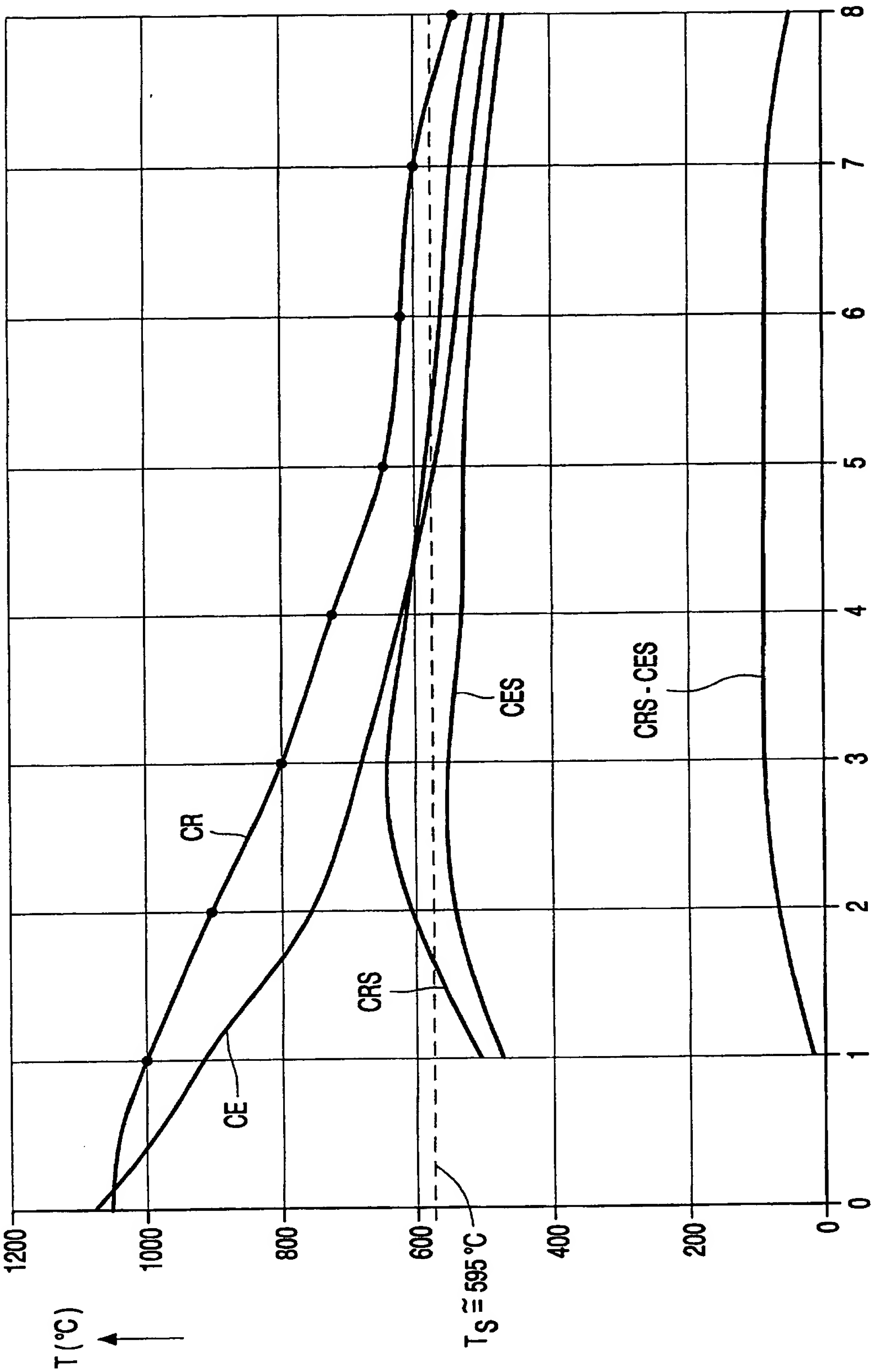
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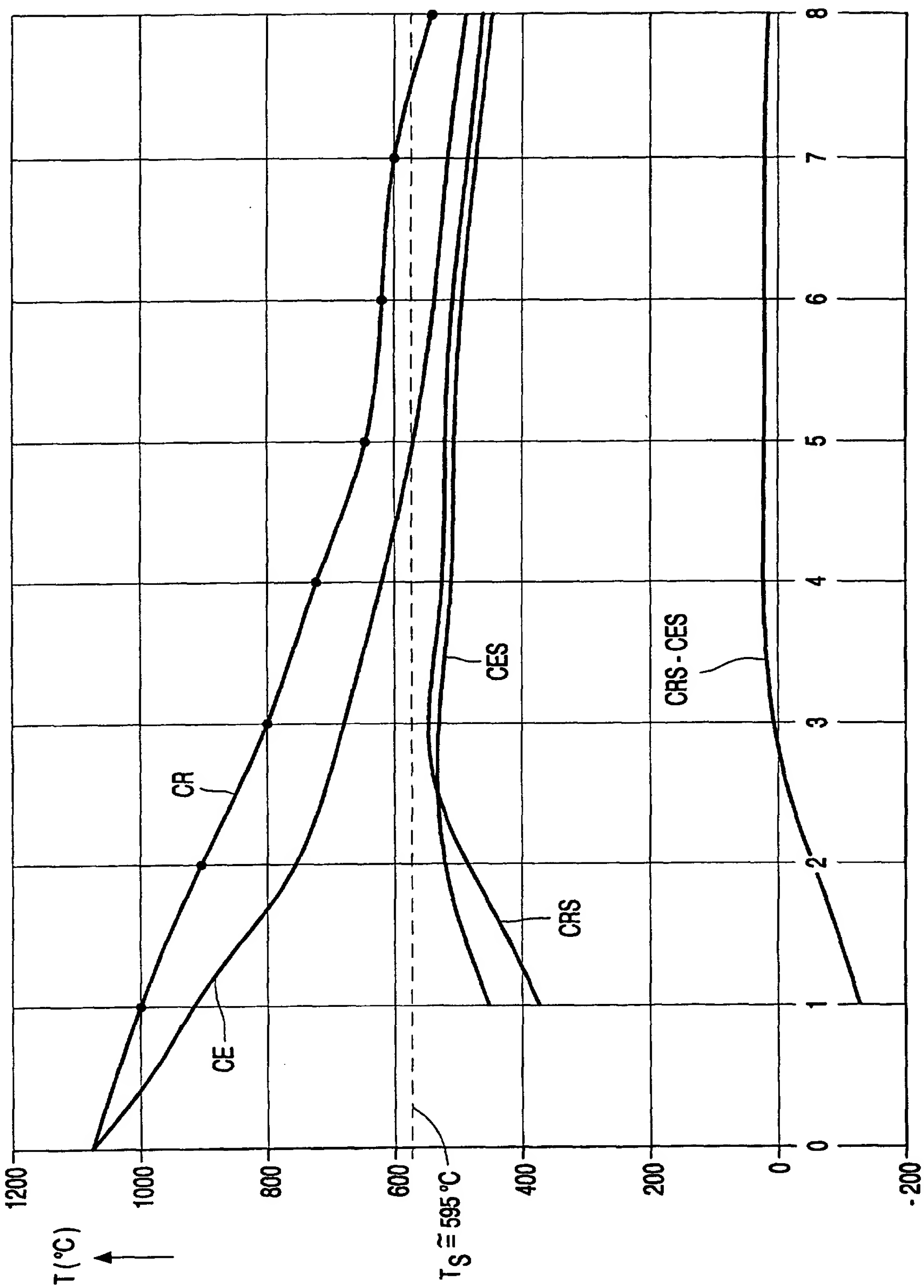
FIG. 4A

FIG. 4B



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